On-Site Oxy-Lance Size Reduction of South Texas Project Reactor Vessel Heads - 12324

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ABSTRACT

On-Site Oxy-Lance size reduction of mildly radioactive large components has been accomplished at other operating plants. On-Site Oxy-Lance size reduction of more radioactive components like Reactor Vessel Heads had previously been limited to decommissioning projects. Building on past decommissioning and site experience, subcontractors for South Texas Project Nuclear Operating Company (STPNOC) developed an innovative integrated system to control smoke, radioactive contamination, worker dose, and worker safety.

INTRODUCTION

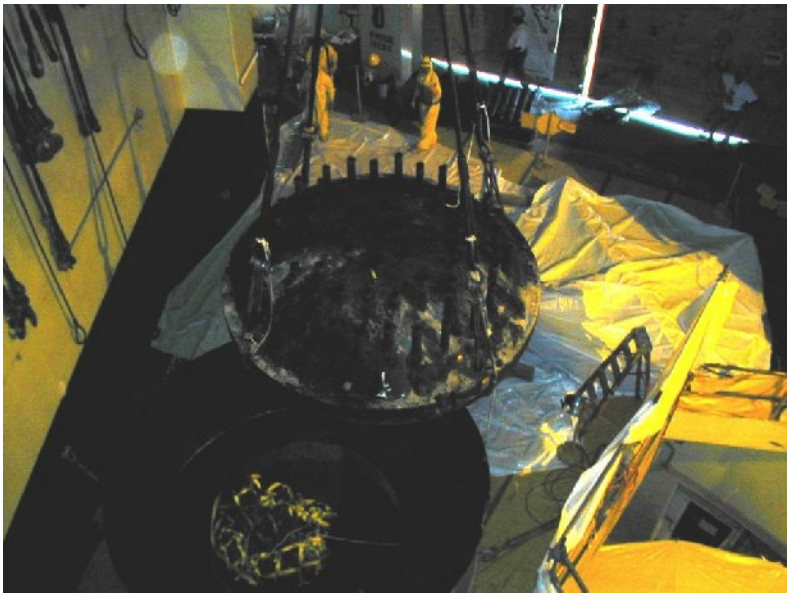
The STP Oxy-Lance system was used to remove the Control Rod Drive Mechanisms (CRDMs) from the intact RVHs in an ALARA manner for separate packaging transport and disposal. The remaining RVH dome-like forgings were also separately packaged for heavy-haul transport and disposal. Challenging project dose and schedule goals were satisfied through savings afforded by use of the STP Oxy-Lance system. Segmentation of retired radioactive large components is frequently advantageous for packaging and transportation savings to support disposal. The challenge associated with segmentation is performance in an ALARA and cost effective manner. Understandably, time savings are common to good ALARA and cost performance.

PAST PERFORMANCE

Decommissioning

Segmentation of Retired Reactor Vessel Heads (RRVHs) has occurred under two different circumstances; decommissioning projects and replacement projects. Some of the first RRVHs were segmented as part of decommissioning projects. Decommissioning project constraints typically differ from replacement project constraints in that they allow for longer decay periods prior to segmentation and generally have larger controlled contamination areas for performance of the segmentation. Longer decay time obviously helps achieve ALARA goals, but larger contamination control areas require vigilance. RRVH segmentation at Maine Yankee was accomplished using Oxy-Lance technology. Oxy-Lance cutting uses oxygen and burning iron rods to develop high temperatures (3870^{o}+ C) that melt RRVH metal in close proximity to the lance tip. Significant amounts of smoke and metal spatter are generated with the Oxy-Lance form of thermal segmentation. Surface contaminants present on RRVH surfaces can become entrained with the metal spatter and to a lesser extent, the smoke. Larger diameter and longer lances are suitable for cutting through thicker metal and segment thinner metal very quickly with more spatter. The long length of large diameter lances permits the operator to be father away from the heat and the dose. The large diameter oxy lance system at Maine Yankee was used to cut through both the RRVH flange, which was constructed of 18 inches of forged Mn-Mo steel and the Control Element Drive Mechanisms, which were 5/8” thick Inconel nozzles (CEDM will be used in this paper even when referring to Control Rod Drive Mechanism). As can be seen in Figure 1, some CEDM nozzle spatter was distributed atop the RRVH exterior.

Figure 1 Maine Yankee RRVH Segment

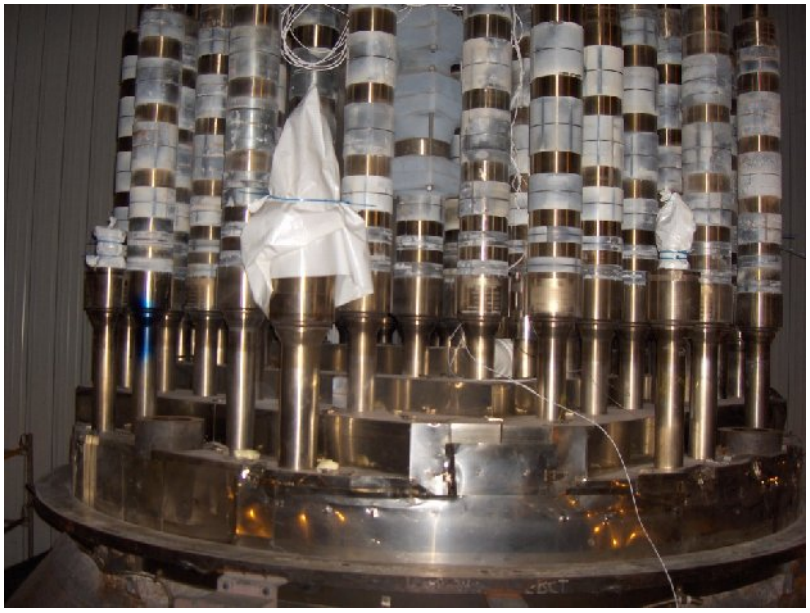


While this method may not be the most attractive, it was sufficient for the radiation protection controls in effect during decommissioning operations (note the sunlight around the door edges in Figure 1). The large diameter lance was very quick to segment the CEDMs and helped to reduce project dose. By segmenting the CEDMs from the RRVH as well as the RRVH forging, Maine Yankee achieved significant packaging and transport cost savings.

Operational Plant Replacements

Early reactor vessel head replacement projects (at operational plants) harvested CEDMs for re-use, and therefore required a less destructive segmentation method. Special milling machines that mechanically cut CEDM conoseals were used at North Anna for CEDM re-use and at DC Cook where the CEDMs were disposed. Conoseal milling machines produce collectible chips rather than spatter, resulting in less of a contamination control challenge while producing no smoke. However, milling machines do require the operator to be in the immediate, high dose vicinity of the CEDMs. Figure 2 demonstrates the close packed nature of CEDMs.

Figure 2 - STP RRVH



Due to the close proximity of the CEDM nozzles, milling machine, and milling machine operator, there is no real opportunity to afford the operator shielding as part of the ALARA plan.

BEST OF BOTH WORLDS

Drawing on past performance for CEDM segmentation, the South Texas Project (STP) selected small diameter oxy-lance thermal segmentation for their specific circumstances.

STP removed the RRVHs from containment and stored them for about a year in a metal skin building within the power block. The STP RRVHs are the largest in the United States and thus have the most to benefit from segmentation to reduce packaging and transport costs. Knowing the time saving benefits offered by oxy-lance segmentation from experience with non-radioactive components, STP was concerned with the smoke generated during segmentation and the potential for the smoke to exit the steel skin building unmonitored. STP invested in mock-ups of the CEDM nozzles that proved benefitial in establishing proper lance size, smoke control, and segmentation technician training.

Smoke & Spatter Control

STP's mock-up testing started with appropriate lance sizing for the CEDM nozzles. The use of a smaller diameter lance (i.e., than that used at Maine Yankee) reduced the amount of spatter from cutting with minor reductions in cutting speed. Mock-up testing also showed that hose-fed general area ventilation (smoke eaters) did not provide optimal smoke containment and control. STP developed a lightweight, two-piece, thin-gauge metal containment that simultaneously provided spatter and smoke control and optimal ventilation.

Figure 3 - STP Segmentation Containment

The STP system was configured with a 6 inch diameter, 2,000 cubic feet per minute hose connection above the cut line which led to pre-filters and then to a HEPA unit. Airflow at the segmentation opening (2,200 feet per second) was nearly enough to extinguish the lance! Glass fiber and Kalsil insulation were used to line the walls of the containment to insulate and to protect the thin-gauge metal. The glass fiber insulation also contained the spatter from segmentation operations and prevented the spread of contaminated spatter particles. The glass fiber insulation could then be periodically disposed with the entrained spatter for contamination control. A "bird's mouth" opening in the front of the containment permitted the oxy-lance operator access to the CEDM nozzle and provided a close horizontal reference to minimize the heat affected zone for

quick, efficient cutting. The two piece containment unit was designed for quick clamping around the CEDM to provide sufficient tolerance to allow minor misalignment without compromising ventilation or insulation.

Performance Enhancement

Production segmentation followed mock-up testing. Two-man teams installed the containment units and retreated to a low dose area. Using the remote controlled mobile gantry crane and a man basket, an initial strain was taken on the CEDM to be cut and the man basket operator retreated to the low dose area. Then the oxy-lance operator moved in to cut the CEDM nozzle. With experience, cutting time was reduced to about a minute per CEDM. By applying the proper strain via the crane, the CEDM was controlled to avoid it falling or compressing and re-fusing the heat affected zone. After a cooling period, the CEDM was moved away from the RRVH for dose profiling and then placed into a shielded rack. As shielded racks were filled with CEDMs, they were removed from the work area to further reduce dose to the workforce. Pre-filters and glass insulation were periodically cleaned out and replaced to maintain system performance.

ALARA CONCLUSION

STP's innovative, easy to use CEDM containment that provided oxy lance access, smoke control, and spatter/contamination control was the key to successful segmentation for cost-effective and ALARA packaging and transport for disposal. Relative to CEDM milling, STP oxy-lance segmentation saved approximately 40 person-REM accrued during 9,000 hours logged into the radiological controlled area (RCA) during more than 3,800 separate entries. Furthermore there were no personnel contamination events or respiratory uptakes of radioactive material during the course of the entire project.